Evaluation of Black Carbon Measurement Methods

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Atmospheric Aerosols

- Adversely affect health via inhalation
- Contribute to climate change via perturbing Earth's energy balance with space
- Two categories: light-absorbing and light-scattering
- Black carbon soot (BC) is primary light-absorber
- Salts (e.g. ammonium sulfate), organics scatter sunlight

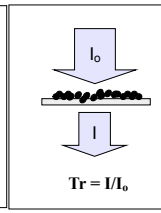
Measuring Black Carbon

- Light transmission through aerosols deposited on white fibrous filter is widely used method for measuring BC
- **Aethalometer** and particle soot absorption photometer (**PSAP**) are most commonly used commercial instruments

PSAP: **Absorption Coef α -ln(Tr)**

Aethalometer: **BC Conc α -ln(Tr)/σ**

(σ treated in Aethalometer as constant, relates light absorption to BC conc)



- Prior work indicates deficiencies in these methods including decreasing instrumental response to absorbing particles as sampling filter becomes loaded

Objective

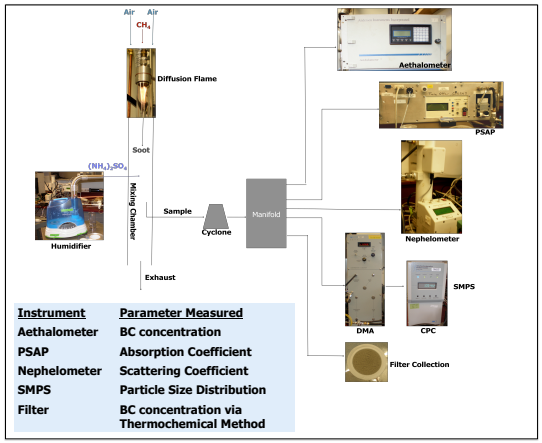
- Evaluate response of Aethalometer and PSAP to aerosols in controlled laboratory setting
- Subject instruments to aerosols that mimic range of atmospheric aerosols:
  - > aerosols near soot sources are mostly light-absorbing, remote aerosols are mostly light-scattering
- Single Scattering Albedo (SSA): measures the relative amount of scattering & absorbing aerosols:

$$SSA = scat / (scat + abs)$$

- SSA ranges from 0.20 (roadway tunnel) to 0.95 (ocean)

Method

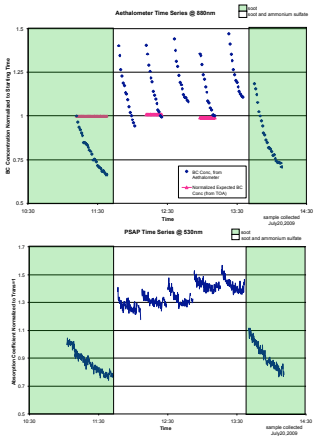
- Generate and mix varying amounts of light scattering and light absorbing aerosol
- Light absorbing soot generated with diffusion flame
- Light scattering aerosol generated with humidifier containing ammonium sulfate solution
- Measure aerosol with instruments shown below



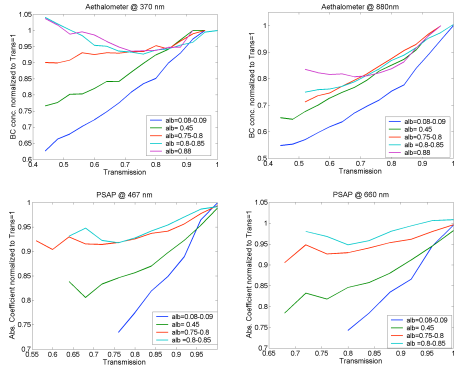
Instrument	Parameter Measured
Aethalometer	BC concentration
PSAP	Absorption Coefficient
Nephelometer	Scattering Coefficient
SMPS	Particle Size Distribution
Filter	BC concentration via Thermochemical Method

Results

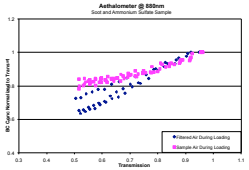
- BC held constant throughout test
- Aethalometer and PSAP erroneously report decreasing quantities of light absorbing aerosol until their filters are replaced
- Instruments respond to light scattering aerosols in addition to BC



Results Continued



- Instrument response decreases with increased aerosol loading of filter at all light wavelengths monitored
- Loading effect is larger at longer wavelengths
- Loading effect largest for low SSA (mostly soot), smallest for high SSA (mostly ammonium sulfate)



- Loading effect is more pronounced if air is filtered of particles during conditioning of clean filter of Aethalometer

Conclusion

- Appreciable errors are encountered while measuring BC with PSAP and Aethalometer, depending on what type of aerosol measured
- Corrections or modifications to instrument should be developed in order to get more accurate results

Acknowledgements

Drs. Thomas Kirchstetter and Odelle Hadley, of the EETD at LBNL. Drs. Jeff Gaffney and Nancy Marley, and Milton Constantin of the DOE GCEP